ANTI-ARMOR MULTIPURPOSE AND CHEMICAL ENERGY PROJECTILES

GOVERNMENT INTEREST

[0001] The invention described herein may be manufactured and used by or for the Government of the United States of America for government purposes without the payment of any royalties therefor.

BACKGROUND OF THE INVENTION

[0002] Field of the Invention

[0003] This invention relates to an armor-penetrating tandem-projectile.

[0004] Description of the Related Art

[0005] Certain types of chemical energy (CE) warheads are formed by cone-shaped metallic liners which are later transformed into a metallic liquid jet by an explosive shaping charge carried on board the projectile. The CE warhead must be activated very near the target (about 1-2 meters) so that the formed metallic jet does not break up. Also, a spacer/spike in front of the liner provides a very short time delay needed to form the jet, when an impact fuse is mounted on the tip of that spacer spike. Alternatively, a proximity fuse may be used instead of the impact fuse if the intended target is moving (as in helicopters) or is relatively distant (4,000-5,000 meters) and a direct impact is less likely to happen. This last scenario is the actual incentive for the concept of multipurpose (MP) projectiles.

[0006] Anti-armor kinetic energy (KE) projectiles are long rods launched at high speed, causing damage due to their kinetic energy (mass and speed). Therefore, they are usually made of high density materials to increase the mass for a given volume.

[0007] U.S. Patent No. 6,109,185 includes several tandem warhead configurations including KE-CE, CE-KE, KE-KE, or CE-CE arrangements. U.S. Patent No. 4,102,271 discloses a KE-CE combination. U.S. Patent No. 5,191,169 shows multiple EFP (explosively formed projectile) configurations. U.S. Patent No. 5,744,746 shows a CE-CE tandem configuration. US Patent No. 4,497,253 shows a KE-KE configuration.

[0008] Figure 1 illustrates a conventional multipurpose (MP) projectile 10, with its typical main components. Projectile 10 includes a metallic conical liner 12 which transforms into a liquid metallic jet after detonation. A conical nose windshield 14 reduces the drag and also provides a stand-off distance between the point of impact and the conical liner 12. A tail fin boom 16 is used to mount a stabilizing fin set piece 18. The tail fin boom 16 is usually screwed to the main body through threads 20 and to the fin set piece 18 through another set of threads 22.

[0009] Figure 2 shows a conventional chemical energy (CE) projectile 30 also known as a HEAT (High Explosive Anti-Tank) projectile. It also has a metallic conical liner 32 and a front stand-off spacer 34, usually referred to as "the spike." The solid tail fin boom 36 is also used to mount the stabilizing fin set piece 38. The tail fin boom 36 is attached to the main body of the projectile through threads 40, and a fin set piece 38 is attached to the tail fin boom 36 through another set of threads 42. In both Figures 1 and 2, the boom is usually solid (no internal holes or cavities) and only serves to carry the stabilizing fins.

[0010] Figure 3 illustrates details of tail fin boom 50 of the MP projectile of Figure 1, showing the threads 52 needed to connect to the main body of the projectile, as well as threads 54 needed to attach the tail set fins 56, which are part of the fin piece 57, to the tail fin boom.

SUMMARY OF THE INVENTION

[0011] The present invention is directed to a tandem warhead, in which the tail fin boom is provided with an added warhead. The forward-momentum energy released through impact is used as a mechanism for the added warhead release. The present invention includes a restraining mechanism to restrain the added warhead from spin slipping with respect to the spinning carrier projectile and to restrain the added warhead from backward movement at launch (set back), by resting the rod rear-end on an impact load-carrying end-piece. The restraining mechanism alters upon impact of the projectile to enable forward release of the added warhead through the destruction of the threads on a front screwing nut.

[0012] More particularly, the present invention increases the lethality of MP and CE warhead projectiles, by utilizing and converting the tail fin boom into a tube carrying an added high-density KE penetrator rod warhead. The penetrator rod is positioned to impact the target after the detonation of the front main CE or MP warhead. The release mechanism for the added KE penetrator rod is the forward momentum energy released by the stoppage of the main carrier projectile upon impact with the target. Upon impact, the added penetrator slips forward, following into the hole created by the MP/CE liquid metal jet, imparting more kinetic energy and causing deeper penetration damage to the target.

[0013] The present invention can be applied to both categories of projectiles (MP projectiles and fin-stabilized CE projectiles) and can be applied as well to the existing stock of both 120mm and 105mm CE and MP munitions. To retrofit the existing stock, the tail boom must be modified, and the fin unit, usually screwed onto the tail fin boom, must be modified to account for the heavier weight of the added KE warhead.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 is a cross-sectional view of a conventional multipurpose projectile configuration.

[0015] Figure 2 is a cross-sectional view of a conventional chemical energy warhead projectile.

[0016] Figure 3 is a cross-sectional view of a conventional tail fin boom of a multipurpose anti-armor projectile.

[0017] Figure 4 is a cross-sectional view of an added KE penetrator rod warhead in a modified tail fin boom according to the present invention.

[0018] Figure 5 shows details of the added KE penetrator rod warhead shown in Figure 4.

[0019] Figure 6 is a cross-sectional view of detail area (A) of Figure 4, showing the front support design for the added KE penetrator rod warhead.

[0020] Figure 7 is a cross-sectional view of the front screwing nut 70 of Figure 6.

[0021] Figure 8 is a cross-sectional view of an adapter piece 68, of Figure 6.

[0022] Figure 9 is a cross-sectional view of detail area (B) of Figure 4, showing the rear support design for the added KE penetrator rod warhead.

[0023] Figure 10 is a cross-sectional view of the release of the added KE penetrator rod warhead and the carrier projectile upon impact with a target.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Figure 4 shows an anti-armor projectile according to the present invention. The projectile includes a tail fin boom 50, front threads 52, rear threads 54, fins 56, and a fin set piece 57. The tail fin boom has a fin-end (first end), and a main body end (second end). An added kinetic energy rod warhead 58 is housed in a long central hole provided in the tail fin boom itself. This added rod warhead is shown in Figure 5. The rod warhead 58 may be of circular cross section as given by section E – E, among other possible shapes. The rod warhead is usually made of high-density material (e.g., tungsten or depleted uranium). The embodiment of Figure 5 shows the rod with stepped-down ends 60, 62, 64, and 66. Reduced size ends are needed to arrange for the support, resting, and attachment of the added warhead to the main carrier body of the projectile. The front-step 60 and rear-step 62 are non-circular as shown by sections C – C and G – G of Figure 5. The steps 64 and 66 are depicted as being of circular cross section by sections D – D and F – F of Figure 5; however, they can also be of any other cross sectional shape.

[0025] The present invention provides novel features to enable the functioning of the added warhead. First, the added warhead should not spin relative to the spinning carrier projectile. Such relative spin may cause in-flight dynamic instability for the carrier projectile or cause inaccuracy in target hitting. Second, the added warhead should be supported at its rear end (toward the fins) such that the support part can withstand the inertia force due to the large launch

acceleration (set-back force). Third, the added warhead must be restrained from relative axial movement (relative to the main carrier projectile); however, it also must be able to be released freely forward, when the carrier projectile movement is suddenly halted at impact with a target. The present invention provides for these three considerations to be satisfied in the warhead and the carrier projectile. These features are described next for the preferred embodiment.

[0026] Figure 6 depicts the front end 60 of the rod which enables a resting function and the forward release arrangement. The front end 60 is of non-circular cross section, a square section in this embodiment, for example. This square end 60 rests inside a matching shaped hole of a small sleeve piece 68. This sleeve piece 68 is connected to the carrier projectile through a screwing nut 70 which is screwed to the inner body of the carrying projectile 72 through restraining threads 74. The screwing nut 70 may have a hexagonal head to allow for the assembly and tightening of the warhead assembly to allow substantially no relative motion between the main carrier projectile and the newly added warhead rod. The threads on the screwing nut 70 (i.e., the restraining threads 74) are precalculated to fail (by being sheared off) by the forward momentum force of the rod warhead 58 at the moment of impact with the target. Details of both the tightening nut 70 and the adjacent small sleeve piece 68 are shown in Figures 7 and 8 respectively.

[0027] The rod rear end 62 is also of non-circular cross section (square in the present embodiment of Figure 5) to be matched in a corresponding non-circular recess in the fin set piece 57, as shown in Figure 9. The end of the rear non-circular end 62 must rest on a surface 78 of the fin set piece 57, to withstand the rod acceleration inertia force load generated at launch.

[0028] Figure 10 shows the operation of the added rod warhead. When a MP projectile, using either an impact fuse or a proximity fuse, impacts a target surface 80, the rear part of the projectile represented by the tail fin boom 50 proceeds forward toward the target surface 80. The inertia force of the rod warhead 58 will push forward the short sleeve piece 68 which will in turn push forward the tightening nut 70. The threads on the tightening nut 70 will shear off from the tail fin boom 50 and both pieces will move forward, followed by the rod warhead 58 which has lost its restraining obstacles. The rod warhead 58 will move forward inside the just created hole 84 created by the main CE warhead (for the impact-fuse scenario), or hit the solid surface 80 causing a new hole and added damage (in the proximity-fuse scenario), where the debris 82 is shown. In either case, more damage is done to the target 80 than if the boom had no added rod warhead 58.

[0029] The above-described embodiments illustrate various non-limiting arrangements of the present invention. The scope of the present invention is limited only by the breadth of the attached claims. Every aspect of the design or fitting of parts, threads, and the like can be easily changed in location, size, or type, without departing from the basic teachings of this invention. Varying rod warhead size, length, mass, shape, or other parameters to obtain enhanced lethality performance over the given configuration is within the scope of this invention. Changes by those skilled in the art to rearrange or improve this design in terms of easier manufacturability, cost, material choice, or lethality performance fall within the scope of the present invention.